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<p>(21) International Application Number: PCT/NL93/00193 (22) International Filing Date: 1 October 1993 (01.10.93) (30) Priority Data: 105185 28 March 1993 (28.03.93) IL 105269 1 April 1993 (01.04.93) IL (71) Applicant (for all designated States except US): INDIGO N.V. [NL/NL]; Luchthavenweg 59-VII, NL-5507 SM Veldhoven (NL). (72) Inventors; and (75) Inventors/Applicants (for US only): YOUNES, Hani [IL/IL]; P.O. Box 138, 30025 Ara Village (IL). KANDER, Ilan [IL/IL]; 14 Netiv Halamed Hai, 43000 Raanana (IL). LEVY, Dornon [IL/IL]; 22 Bezalel Street, 64683 Tel Aviv (IL). COHEN, Yossi [IL/IL]; 14 Meltzer Street, 76285 Rehovot (IL). BELINKOV, Haim [IL/IL]; 34 Hagdud Ha'Ivri Street, 75301 Rishon Le Zion (IL). (74) Agent: DE BRUIJN, Leendert, C.; Nederlandsch Octrooibureau, Scheveningseweg 82, P.O. Box 29720, NL-2502 LS The Hague (NL).</p>		<p>(81) Designated States: CA, JP, KR, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published With international search report.</p>
<p>(54) Title: IMAGING SYSTEM HAVING AN INTERMEDIATE TRANSFER MEMBER</p> <p>(57) Abstract</p> <p>Imaging apparatus including an image bearing surface (16), apparatus means for forming a toner image on the image bearing surface and an intermediate transfer member (40) comprising a release surface (50) suitable for receiving liquid toner images comprising toner particles and a hydrocarbon carrier liquid from a first surface (16) and for transferring them to a second surface (42), wherein the release surface (50) comprises a material which absorbs or solvates the carrier liquid. The imaging apparatus further includes first transfer apparatus (31) for transferring the image from the image bearing surface (16) to the intermediate transfer member (40), liquid removal apparatus (62) for removing carrier liquid absorbed or solvated by the release surface, the liquid removal apparatus (62) being located downstream of the first transfer apparatus and second transfer apparatus for transferring the image from the intermediate transfer member (40) to a further surface (42).</p>		

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1 IMAGING SYSTEM HAVING AN INTERMEDIATE TRANSFER MEMBER

2 FIELD OF THE INVENTION

3 The present invention relates to imaging apparatus in
4 general and, more particularly, to liquid toner imaging
5 apparatus which employs an intermediate transfer member for
6 transfer of images from an imaging surface to a final
7 substrate.

8 BACKGROUND OF THE INVENTION

9 Imaging systems which utilize intermediate transfer
10 members are well known.

11 U.S. Patent 5,047,808, which is commonly assigned with
12 the present application and which is incorporated herein by
13 reference, describes a liquid toner imaging system having an
14 intermediate transfer member with a silicone rubber release
15 coating.

16 PCT publication WO 90/14619, which is commonly
17 assigned with the present application and which is
18 incorporated herein by reference, describes a liquid toner
19 system having an intermediate transfer member with a
20 silicone rubber coating. The images are heated on the
21 intermediate transfer member to a temperature at which the
22 polymer in the toner particles solvates the carrier liquid
23 and is thereby plasticized. The image, including the liquid
24 carrier therein, is transferred in its plasticized state to
25 the final substrate.

26 PCT publication WO 92/10793, which is commonly
27 assigned with the present application and which is
28 incorporated herein by reference, describes a liquid toner
29 imaging system in which the intermediate transfer member is
30 cooled after transfer of the toner image therefrom to the
31 final substrate. The reason for such cooling is to avoid
32 damage to the photoreceptor during transfer of the next

1 image to the intermediate transfer member. The intermediate
2 transfer member has a silicone rubber release coating.

3 U.S. Patent 4,453,820 to Suzuki describes a powder
4 toner imaging system in which the toner is heated to a
5 fusion or melting point on an intermediate transfer member
6 and in which, for high speed operation, the intermediate
7 transfer member is cooled, to avoid damage to the
8 photoreceptor.

9 PCT publication WO 90/04216, which is commonly
10 assigned with the present application and which is
11 incorporated herein by reference, shows a liquid toner
12 imaging system in which the liquid toner image is at an
13 elevated temperature during transfer of the image from the
14 photoreceptor to the intermediate transfer member.

15 U.S. Patent 3,795,033 to Donnelly et al describes a
16 fuser roller for fusing liquid toner images which is coated
17 with a silicone elastomer.

18 SUMMARY OF THE INVENTION

19 The present invention seeks, in certain of its
20 aspects, to reduce the temperature of intermediate transfer
21 members used in liquid toner imaging systems.

22 The present invention seeks, in certain of its aspects
23 to provide a longer lasting intermediate transfer member,
24 especially for use with liquid toner systems.

25 The present invention is especially useful in liquid
26 toner imaging systems. In a preferred liquid toner system a
27 liquid toner image is formed on an imaging surface using
28 liquid toner comprising carrier liquid and toner particles
29 which are substantially insoluble in the carrier liquid but
30 which solvate the carrier liquid at elevated temperatures.

31 Substantial amounts of liquid are preferably removed
32 from the image while it is on the imaging surface and the

1 image is then, preferably electrostatically, transferred to
2 an intermediate transfer member. The image is heated on the
3 intermediate transfer member to a temperature above the
4 solvation temperature so as to enhance its adhesiveness and
5 is then transferred to a final substrate. In some systems a
6 second intermediate transfer member is interposed between
7 the intermediate transfer member and the final substrate.
8 Preferably, enough carrier liquid is removed from the image
9 on the imaging surface that the image (toner particles and
10 carrier liquid) forms a single phase at the temperature to
11 which it is heated on the intermediate transfer member.

12 For multi-color images, liquid toner image layers of
13 various colors are sequentially formed on the imaging
14 surface and are sequentially transferred to the intermediate
15 transfer member for subsequent transfer to the final
16 substrate. In one embodiment the liquid layers are overlaid
17 on the intermediate transfer member and in another
18 embodiment the layers are sequentially transferred to the
19 final substrate (or the second intermediate transfer layer)
20 and are overlaid thereon. In general no further fusing and
21 fixing of the image is required after transfer from the
22 intermediate transfer member to the final substrate.

23 Depending on the toner materials used, transfer from
24 the intermediate transfer member to the final substrate
25 (second transfer) should be possible at relatively low
26 temperatures in accordance with theory. However, when the
27 intermediate transfer member is heated to these low
28 temperatures, the overall transfer process is poor. Second
29 transfer is clearly worse at low temperatures. It is
30 believed that transfer to the intermediate transfer member
31 from the image forming surface (first transfer) is also
32 adversely effected. Thus, at an intermediate transfer member

1 surface temperature of 85°C, images exhibited substantial
2 squash (manifest d as dot spreading) and incomplete
3 transfer.

4 Furthermore, at lower temperatures the intermediate
5 transfer member suffered from a certain amount of
6 unexplained "memory" in which the transfer characteristics
7 of the system were affected by the previously transferred
8 image. Thus, even when all of the toner from the previous
9 image was transferred from the intermediate transfer member
10 to the final substrate, there was a certain amount of
11 ghosting of the previous image on a new and different image.
12 This ghosting was manifested in dot spreading in portions of
13 the intermediate transfer member which bore toner particles
14 on the previous cycle.

15 In a particular machine, if the surface temperature of
16 the intermediate transfer member surface was above 115°C or
17 120°C, there were neither dot spreading nor transfer
18 problems. At temperatures of about 100°C, there were no
19 transfer problems, but dot spreading caused by memory
20 effects was still apparent. Below about 95°C, both dot
21 spreading and transfer problems were apparent.

22 For high speed printers, such as that of the above
23 described apparatus, no post second transfer cooling of the
24 intermediate transfer member is required even at
25 intermediate transfer member surface temperatures of 115°C -
26 120°C, since the photoreceptor is not heated sufficiently
27 during first transfer to cause any change in photoreceptor
28 characteristics or any damage to the photoreceptor.
29 Furthermore, the photoreceptor is cooled to avoid problems
30 of overheating so no cooling of the intermediate transfer
31 member is required by the system as was required in the
32 prior art references noted above.

1 It has been found, however, that the abrasion
2 resistance of the intermediate transfer member is
3 considerably reduced as its temperature is raised in the
4 presence of carrier liquid such as Isopar. It is expected
5 that the life of the member may be shortened when its
6 temperature is raised to the higher temperature at which
7 transfer is satisfactory, or even to the temperature at
8 which transfer problems disappear.

9 The present invention is based on a new understanding
10 of the process of successful first and second transfer,
11 which allows for reduction of the surface temperature of the
12 intermediate transfer member to the surface temperature
13 actually required for second transfer. At this lower
14 temperature, which can be as low as 60°C to 70°C, but is
15 preferably 85°C to 95°C, the lifetime of the intermediate
16 transfer member is markedly improved. Furthermore, since the
17 cohesivity of the toner is higher at the lower temperatures,
18 transfer of the image from the intermediate transfer member
19 should be more complete at the lower temperatures.

20 Some experiments show that both major failure modes of
21 the intermediate transfer member, i.e., loss of release
22 properties and loss of resilience appear to have a strong
23 dependence on temperature, at least above some particular
24 temperature.

25 It should be understood that, as a practical matter,
26 the core of the intermediate transfer member is
27 substantially hotter than its surface. During idle periods
28 or paper jams the surface temperature can rise markedly, so
29 that reduction of the required surface temperature, which
30 carries with it a reduction of the core temperature, is an
31 important consideration.

32 Applicants believe that during first transfer at least

1 some of the carrier liquid, which is present in the liquid
2 toner image in relatively large amounts (about 50-75 percent
3 carrier liquid in the image areas after liquid removal by an
4 electrified squeegee roller), is absorbed by a silicone
5 release coating on the intermediate transfer member. While
6 the amount of liquid which is absorbed is small, this liquid
7 absorption causes the viscosity of the image to increase
8 enough so that the image resists any tendency to squash
9 during first transfer.

10 However, if the lower temperature for the intermediate
11 transfer member is used, the liquid which was absorbed by
12 the very thin silicone release layer apparently remains in
13 the layer when the image is transferred to the final
14 substrate. When the intermediate transfer member is operated
15 at low temperatures, the liquid which remains in the
16 silicone layer reduces or inhibits further absorption of
17 liquid from the next transferred image. Furthermore, it
18 appears that the amount of liquid remaining in the release
19 layer (and hence the amount which acts to reduce liquid
20 absorption in the next image transfer) is different for
21 print and non-print areas of the image, resulting in the
22 aforementioned ghosting.

23 This retention of liquid in the image appears to have
24 a strongly deleterious effect on second transfer as well. It
25 is believed that, when the amount of liquid in the image is
26 decreased, the toner particles more easily form a single
27 phase with the liquid at a lower temperature than if there
28 is an excess of carrier liquid. When the image is in a two
29 phase situation, squash can more easily occur since the
30 toner particles are somewhat free to move in the excess
31 liquid. When the toner is in a single phase, all of the
32 liquid is absorbed by the toner particles and movement of

1 the particles during second transfer is less likely.

2 Furth rmore, complete second transfer is enhanced by
3 increased viscosity of the image. When the particles are
4 contained in unsolvated (free) liquid, the overall viscosity
5 of the image is reduced and splitting of the image and
6 incomplete transfer may result. However, the viscosity of
7 the toner particles themselves does not depend on the excess
8 carrier liquid so that transfer to the final substrate is
9 not adversely affected when the excess liquid is removed.

10 In some aspects of the present invention, means are
11 provided for removing absorbed liquid from the intermediate
12 transfer member after second transfer and before subsequent
13 first transfer of a subsequent image.

14 One way to remove this carrier liquid is by heating
15 the intermediate transfer member during the period between
16 second transfer and first transfer of the subsequent image.
17 This was apparently the major positive effect of heating the
18 intermediate transfer member to above 115°C to 120°C as
19 described above.

20 The present inventors have also found that when air at
21 room temperature is blown over the surface of the
22 intermediate transfer member downstream of second transfer,
23 the vapor pressure of the carrier liquid is reduced and
24 removal of the minute amounts of carrier liquid in the
25 release layer is effected. Blowing heated air over the
26 surface of the intermediate transfer member has the same
27 salutary effect as using room temperature air. When air is
28 blown over the surface, the surface temperature of the
29 intermediate transfer member can be reduced to 95°C with no
30 problems. For lower temperatures, carrier liquid removal is
31 low even when air is blown on the surface after second
32 transfer.

1 In a further embodiment of the invention, oxime cured
2 silicone rubber is used as the outer release layer of the
3 intermediate transfer member. It has been surprisingly found
4 that such oxime cured materials have much longer life than
5 silicone rubber cured by other systems. Such oxime cured
6 rubbers in general do not appear to require any fillers for
7 strengthening as do other materials and as was previously
8 believed was required, although filled material can be used.

9 It is believed that this longer life of the oxime
10 cured systems is based on improved retention of their
11 release properties when attacked by ozone, which is produced
12 during the operation of most electrostatographic copiers and
13 printers.

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1 BRIEF DESCRIPTION OF THE DRAWINGS

2 The present invention will be better understood from
3 the following detailed description of preferred embodiments,
4 taken in conjunction with the following drawings of which:

5 Fig. 1 is a simplified schematic sectional
6 illustration of a liquid toner image system in accordance
7 with a preferred embodiment of the invention;

8 Fig. 2 is a perspective drawing of an air distributor
9 in accordance with a preferred embodiment of the invention;
10 and

11 Fig. 3 is a graph showing the effect of removing
12 entrapped carrier liquid from a silicone rubber release
13 layer of an intermediate transfer member on the required
14 temperature of the member.

15 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

16 Fig. 1 shows a preferred electrostatographic system in
17 accordance with a preferred embodiment of the invention. The
18 preferred system utilizes a drum 10 formed with a
19 cylindrical image forming surface such as a photoreceptor
20 surface 16, arranged for rotation about an axle 12 in a
21 direction generally indicated by arrow 14.

22 A charger 18 such as, for example, a corona discharge
23 device, is operative to generally uniformly charge
24 photoreceptor surface 16 with a charge of a given polarity.
25 Continued rotation of drum 10 brings charged photoreceptor
26 surface 16 into image receiving relationship with an
27 exposure unit 20. Unit 20 focuses a desired image, which may
28 be laser generated, onto charged photoreceptor surface 16,
29 selectively discharging the photoreceptor surface, thus
30 producing an electrostatic latent image thereon. Unit 20 may
31 be a laser scanner, an ionographic imaging unit or may be an
32 optical system for projecting an image of a document to be

1 copied.

2 Continued rotation of drum 10 brings charged
3 photoreceptor surface 16 bearing the electrostatic latent
4 image into operative association with a development unit 22,
5 which is operative to apply a liquid developer to develop
6 the electrostatic latent image. For multicolor copying or
7 printing, development unit 22 can, for example, comprise a
8 plurality of developers, one for each color, which are
9 selectively engaged with the photoreceptor, as described,
10 for example, in U.S. Patent 4,690,539, the disclosure of
11 which is incorporated herein by reference. Alternatively a
12 single development station where the liquid toner is changed
13 between colors, or any other suitable development system may
14 be used. In general, the development process takes place at
15 a relatively low temperature, namely approximately the
16 temperature of the environment of the system. Other
17 preferred development systems such as those described in
18 U.S. Patent 5,148,222 are also suitable for use with the
19 invention.

20 In accordance with preferred embodiments of the
21 invention, liquid toners comprising toner particles,
22 preferably particles having fibrous extensions, and carrier
23 liquid are utilized in development unit 22. Types of liquid
24 toner which are especially useful in the practice of the
25 invention are described in U.S. Patent 4,794,651, the
26 disclosure of which is incorporated herein by reference.
27 Preferably, solvating liquid toner, comprising carrier
28 liquid and toner particles which are substantially insoluble
29 in the liquid and which solvate the liquid at elevated
30 temperatures, as described in U.S. Patent 4,794,651 is used.

31 In accordance with a preferred embodiment of the
32 invention, following application of toner thereto,

1 photoreceptor surface 16 passes a typically positively
2 charged rotating roller 26, preferably rotating in a
3 direction indicated by an arrow 28. Roller 26 functions as a
4 metering roller and reduces the thickness of liquid on
5 photoreceptor surface 16. Typically the spatial separation
6 of roller 26 from photoreceptor surface 16 is about 50 to 70
7 micrometers.

8 Preferably the voltage on roller 26 is intermediate
9 the voltages of the latent image areas and the background
10 areas on the photoreceptor surface. Typical voltages are:
11 roller 26: -200V, background area: about -1000V and latent
12 image areas: about -150V.

13 When a reverse roller type developer is used, roller
14 26 is generally unnecessary, except that, in certain high
15 speed systems, a negatively charged roller as described in
16 PCT publication WO 92/13299 may be used to remove toner
17 particles on the background.

18 Liquid which passes roller 26 (or the reverse roller
19 developer) should be relatively free of pigmented particles
20 except in the region of the latent image.

21 Downstream of roller 26 (or the reverse roller
22 developer) there is preferably provided a rigidizing roller
23 30. Rigidizing roller 30 is preferably formed of a resilient
24 polymeric material, such as conductive resilient polymeric
25 material as described in either or both of U.S. Patents
26 3,959,574 and 3,863,603. Roller 30 is preferably resiliently
27 urged against photoreceptor surface 16.

28 In a preferred embodiment of the invention, a
29 rigidizing roller 30 operates as a biased squeegee roller.
30 Roller 30 is negatively charged to a potential of at least
31 several hundred and up to 2000 volts with the same sign as
32 the charge on the pigmented toner particles, so that it

1 repels similarly charged pigmented particles and causes them
2 to approach the image areas of the photoreceptor surface 16
3 more closely, thus compressing and rigidizing print areas of
4 the image and facilitating the removal of liquid therefrom
5 and from background (non-print) areas. Use of such
6 rigidizing rollers to remove liquid from images is described
7 in U.S. Patent 5,028,964.

8 The image next passes a pre-transfer irradiation
9 station, preferably comprising a light source 31. Use of
10 pre-transfer erase for discharging photoreceptors in
11 reversal developed imaging is taught in U.S. Patent
12 5,166,734, the disclosure of which is incorporated herein by
13 reference.

14 Downstream of rigidizing roller 30 there is provided
15 an intermediate transfer member 40, which rotates in a
16 direction opposite to that of photoreceptor surface 16, as
17 shown by arrow 41, providing substantially zero relative
18 motion between their respective surfaces at the point of
19 propinquity. Intermediate transfer member 40 is operative
20 for receiving the toner image from photoreceptor surface 16
21 and for transferring the toner image to a receiving
22 substrate 42, such as paper. Disposed internally of
23 intermediate transfer member 40 there may be provided a
24 heater 46. The image on the intermediate transfer member may
25 also be heated by an external heater prior to its transfer
26 from the intermediate transfer member. In a preferred
27 embodiment of the invention the intermediate transfer member
28 comprises a soft layer 48 which is coated with a release
29 coating layer 50.

30 Various types of intermediate transfer members are
31 known and are described, for example in U.S. Patent
32 4,984,025; 5,047,808 and in assignee's co-pending U.S.

1 Patent application 7/293,456 filed January 4, 1989, the
2 disclosures of which are incorporated herein by reference.
3 While the intermediate transfer member is shown as a solid
4 drum coated with an intermediate transfer layer, a removable
5 intermediate transfer blanket or a belt type intermediate
6 transfer member may also be used in the practice of the
7 invention.

8 Preferably, the intermediate transfer member is
9 electrically biased to attract the charged toner particles
10 from the photoreceptor surface.

11 The intermediate transfer members which are especially
12 useful in some of the preferred embodiments of the invention
13 utilize silicone rubber or silicone release coating material
14 as the release coating 50. Such materials are generally
15 polydimethyl siloxanes with or without phenyl.

16 In an especially preferred embodiment of the
17 invention, silicone rubbers which are oxime cured
18 (preferably containing ketoxime groups as a cross-linking
19 agent) are used as the release coating. These oxime cured
20 materials generally have less extensive utility and are less
21 widely available than materials utilizing other cure
22 systems. However, in the present application as a release
23 coating for intermediate transfer members, they have a very
24 long life compared to silicone rubbers having other cure
25 systems. The present inventors believe that oxime cured
26 silicone rubbers are more ozone resistant than other
27 silicone rubbers. Due to the presence of substantial
28 concentrations of ozone in imaging systems of the type of
29 the invention, this characteristic is of great importance.

30 In a preferred embodiment of the invention, soft layer
31 48 underlies the release layer. This soft layer is
32 preferably prepared as follows:

1 1- One Kg of Fomrez F50 polyurethane resin (Witco)
2 is sintered under vacuum at 70 degrees Celsius;

3 2- The produce of step 1 is degassed at 120 degrees
4 Celsius (in a hot oil bath) while being stirred under vacuum
5 conditions. The resulting material is stored under dry
6 storage conditions;

7 3- 20 grams of the result of step 2, 2.2 grams of
8 RTV silicone 118 (General Electric, USA) and 2.7 grams of
9 polymethylene diphenyl isocyanate are stirred together; and

10 4- A 100 micrometer thick layer of the results of
11 step 3 is coated on the lower layers of the intermediate
12 transfer layer using a Bar #3 wire rod with three passes
13 under clean conditions (class 100). The soft layer is cured
14 for 16 hours at room temperature under clean conditions,
15 followed by two hours at 130 degrees Celsius. Alternatively,
16 the material is cured at 70 degrees Celsius for ten minutes,
17 followed by two hours at 130°C.

18 Preferably, this soft layer is coated onto a
19 compressible layer such as known in the art.

20 In a preferred embodiment of the invention the
21 silicone release coating is prepared and coated onto the
22 intermediate transfer member by the following method.

23 1- 12 grams of RTV Silicon 236 (DOW CORNING) is
24 diluted with 2.0 grams of Isopar L and 0.72 grams of Syl-Off
25 297 (DOW CORNING). This material is oxime cured; and

26 2- A wire rod (bar #1) coating system is used, with
27 three passes, under class 100 clean conditions to achieve a
28 7±1 micrometer release layer thickness. The material is
29 cured at 150 degrees Celsius for two hours.

30 Other oxime cure system materials are also utilized in
31 preferred embodiments of the invention. Such materials
32 include Nu-Sil R-1007, R-1008, R-1009, R-1010, R-1030, R-

1 1048, R-1075, R-1130, R-1600, R-1505, CV-1142, CV-1142-2,
2 CV-1143, CV-1143-1, CV-1144-0, CV-1144-2, CV-1152 and CV-
3 1500 oxime cured silicone materials marketed by McGhan NuSil
4 Corporation of Carpintera, California.

5 While these oxime cured materials are most preferred,
6 other materials such as Syl-Off 294 and other silicone
7 rubbers are also useful as release layers for intermediate
8 transfer members.

9 Following the transfer of the toner image to
10 intermediate transfer member 40, photoreceptor surface 16
11 preferably engages a cleaning station 52. This station may
12 be any conventional cleaning station, including a cleaning
13 roller which may comprise a suitable resilient material such
14 as foam polyethylene or neoprene. The cleaning roller may be
15 wetted by clean lubricating cleaning liquid, which
16 preferably comprises liquid developer from which all or
17 nearly all of the toner particles have been removed. The use
18 of a cooled clean liquid in the cleaning station also has
19 the desired effect of cooling the photoreceptor and avoiding
20 temperature creep of the photoreceptor due to its contact
21 with the intermediate transfer member. The cleaning roller
22 is driven so that its surface moves opposite to surface 16
23 at their nip, to provide scrubbing action for removal of
24 residual particles and carrier liquid from photoreceptor
25 surface 16. An optional scraper completes the removal of any
26 residual toner which may not have been removed by the
27 cleaning roller.

28 A lamp 60 completes the cycle by removing any residual
29 charge, characteristic of the previous image, from
30 semiconductor surface 16.

31 While a lamp 60 is conventional, the present inventors
32 have found that, at least for reversal development, when

1 pre-transfer irradiation is used together with an
2 electrified intermediate transfer member, lamp 60 is not
3 generally required. In this case, the pre-transfer
4 irradiation followed by the positive electrification of the
5 photoreceptor by the intermediate transfer member act to
6 make such discharge inoperative. The use of a scorotron as
7 charger 18, for charging the photoreceptor, is indicated in
8 such situations.

9 Transfer of the image to intermediate transfer member
10 40 is preferably aided by providing electrification of
11 intermediate transfer member 40 to a voltage generally
12 having a polarity opposite to that of the charged particles,
13 thereby causing electrostatic transfer of the particles to
14 the intermediate transfer member. A portion of the carrier
15 liquid is also transferred to the intermediate transfer
16 member.

17 Subsequent final transfer of the image from
18 intermediate transfer member 40 to substrate 42 is
19 preferably aided by heat and pressure. A higher temperature
20 than that used for first transfer is preferably utilized for
21 this subsequent final transfer, in accordance with the
22 present invention.

23 In the present invention the preferred second transfer
24 step, i.e., the transfer of the liquid toner image to the
25 final substrate, includes the heating of the image before
26 and/or during second transfer. This further heating can be
27 achieved by heating the image on intermediate transfer
28 member 40, for example by heat transfer from intermediate
29 transfer member 40 during the interval between first and
30 second transfer and/or by external heating of the image.
31 Alternatively or additionally the further heating can be
32 achieved by conduction heating of the image from the

1 substrate during second transfer.

2 For multicolor systems, in accordance with a preferred
3 embodiment of the invention, the individual color images are
4 first transferred to the intermediate transfer member and
5 then transferred, in aligned configuration, separately, to
6 the final substrate. Alternatively it may be useful to
7 sequentially transfer the separate colors to intermediate
8 transfer member 40 in alignment with and generally
9 superimposed on and in registration with each other and then
10 to transfer them together to paper or other substrate 42.

11 It is a characteristic of silicone rubber materials
12 and of silicone release coatings that such materials solvate
13 large amounts of the hydrocarbon liquids generally used as
14 carrier liquids in liquid toners. When silicone materials
15 solvate carrier liquid they become swollen. Nevertheless, it
16 has been surprisingly found that coating an intermediate
17 transfer member with such materials which absorb or solvate
18 carrier liquid (especially when the outer layer is thin)
19 results in improved transfer of the image from the
20 photoreceptor to the intermediate transfer member and from
21 the intermediate transfer member to the final substrate.
22 Preferably, such layers should have a thickness less than
23 three millimeters and more than 2 micrometers, with 2-3, 7,
24 10 and 100 micrometers and two millimeters being
25 representative values.

26 It should be understood that, while the surface layer
27 absorbs the liquid, the surface layer is preferably a non-
28 porous, smooth layer. The absorption of the liquid is
29 accomplished by swelling of the surface layer.

30 It has been a goal of the prior art to remove excess
31 liquid from liquid toner images before or during transfer of
32 the image to the final substrate. This is useful for

1 reducing squash during transfer. Transfer to a smooth
2 surfaced intermediate transfer member generally will not
3 result in any drying of the image and related rigidizing.
4 However, when the release coatings of the present invention
5 are used, nearly instantaneous drying of the image during
6 transfer to the intermediate transfer member occurs
7 resulting in more squash free transfer of the image.

8 In some cases when subsequent copies are made at short
9 intervals and new images are transferred to the intermediate
10 transfer member, the advantageous effects of the coating are
11 apparently reduced. This is believed to be the result of
12 carrier liquid which remains in the release layer and
13 reduces the amount of liquid which is absorbed in subsequent
14 transfers.

15 There is therefore provided, in a preferred embodiment
16 of the present invention, means 62 for removing carrier
17 liquid absorbed by the release layer of an intermediate
18 transfer member after transfer of an image therefrom.

19 In one embodiment the means for removing comprises a
20 fan which blows air onto the surface of the intermediate
21 transfer member. This flow of air reduces the vapor pressure
22 of the carrier liquid at the surface of the intermediate
23 transfer member and aids in evaporation of the absorbed
24 liquid carrier therefrom. Generally, this air flow is at
25 room temperature; but, heated air works equally well in the
26 present invention.

27 While it is known, at least in the powder toner art,
28 to cool intermediate transfer members before they contact
29 the photoreceptor, to avoid damage to the photoreceptor; in
30 the present invention, such air flow is applied even when
31 the temperature of the intermediate transfer member and
32 amount of time which it contacts the photoreceptor are such

1 that no damage to the photoreceptor would result.
2 Furthermore, for the air flow rates described below,
3 measurements have shown that no appreciable cooling of the
4 intermediate transfer member occurs.

5 Further, the end result of the practice of the
6 invention is to reduce the amount of heating of the
7 intermediate transfer member so that, even during second
8 transfer, the member operates at a lower temperature than
9 would otherwise be required. This is best understood by
10 realizing that heating the intermediate transfer member to a
11 higher temperature than is actually required for good second
12 transfer also acts to remove absorbed carrier liquid from
13 the absorbent surface.

14 Fig. 2 shows a preferred embodiment 63 of an air flow
15 device 62 for blowing air on the photoreceptor. Device 63
16 comprises a capped hollow tube 64 which is pierced by a
17 plurality of holes 66 along its length. These holes face the
18 intermediate transfer member and distribute a relatively
19 uniform flow of air on its surface. Fig. 3 shows a graph of
20 flow rate as a function of blanket surface temperature. In
21 this graph, operation to the right of the curve resulted in
22 acceptable operation and operation to the left of the curve
23 was not satisfactory, presumably because of squash on first
24 or second transfer. The length of the tube is about 300mm.
25 Memory effects continued up to surface temperatures of 115°C
26 to 120°C.

27 Alternatively, in a preferred embodiment of the
28 invention, the holes may be replaced by slots or by a single
29 slit running the length of the device.

30 It is seen that the surface temperature of the
31 intermediate transfer member can be reduced by 20-35°C using
32 moderate air flows, which by themselves do not substantially

1 decrease the intermediate transfer member's temperature.
2 Temperature reductions of 20-35°C are very significant with
3 respect to intermediate transfer member life and safety of
4 the system in case of jams. It should be understood that
5 internal heater 46 is generally set at a higher temperature
6 (up to 60°C higher) than the desired surface temperature.
7 During paper jams, portions of the surface can reach this
8 higher temperature. In addition, the photoreceptor surface
9 temperature increases. These effects can be deleterious to
10 future operation of the system and sometimes can be
11 dangerous.

12 It is thus seen that reduction of the intermediate
13 transfer member surface temperature has a multiplicity of
14 beneficial effects.

15 While the present invention has been described with
16 reference to the preferred embodiments thereof, the
17 invention is defined solely by the following claims:
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CLAIMS

- 1
2 1. Intermediate transfer apparatus for an imaging machine
3 comprising:
4 an intermediate transfer member having a release
5 surface suitable for receiving liquid toner images
6 comprising toner particles and a hydrocarbon carrier liquid
7 from a first surface and for transferring them to a second
8 surface, wherein the release surface comprises an oxime
9 cured silicone material.
10
11 2. Imaging apparatus comprising:
12 an image bearing surface;
13 means for forming a toner image on the image bearing
14 surface;
15 an intermediate transfer member comprising a release
16 surface suitable for receiving liquid toner images
17 comprising toner particles and a hydrocarbon carrier liquid
18 from a first surface and for transferring them to a second
19 surface, wherein the release surface comprises a material
20 which absorbs or solvates the carrier liquid;
21 first transfer means for transferring the image from
22 the image bearing surface to the intermediate transfer
23 member;
24 second transfer means for transferring the image from
25 the intermediate transfer member to a further surface; and
26 liquid removal means for removing carrier liquid
27 absorbed or solvated by the release surface, said liquid
28 removal means being located downstream of the second
29 transfer means.
30
31 3. Apparatus according to claim 1 wherein the silicone
32 material is a silicone rubber.

1

2 4. Apparatus according to claim 2 wherein the release
3 surface comprises a silicone material.

4

5 5. Apparatus according to claim 4 wherein the silicone
6 material comprises an oxime cured silicone rubber.

7

8 6. Imaging apparatus comprising:

9 and image bearing surface;

10 means for forming a toner image on the image bearing
11 surface;

12 an intermediate transfer member according to claim 1
13 or claim 3;

14 first transfer means for transferring the image from
15 the image bearing surface to the intermediate transfer
16 member; and

17 second transfer means for transferring the image from
18 the intermediate transfer member to a further surface.

19

20 7. Apparatus according to claim 6 and also including
21 liquid removal means located downstream of the second
22 transfer means for removing carrier liquid absorbed or
23 solvated by the release surface.

24

25 8. Apparatus according to any of claims 2, 4, 5 or 7
26 wherein the liquid removal means comprises means for heating
27 the intermediate transfer member after transfer of the image
28 from the intermediate transfer member.

29

30 9. Apparatus according to any of claim 2, 4, 5 or 7
31 wherein the liquid removal means comprises means for flowing
32 a current of air along the surface of the intermediate

1 transfer member after transfer of the image therefrom.

2

3 10. Apparatus according to claim 9 wherein the current of
4 air does not substantially reduce the temperature of the
5 intermediate transfer member over what it would be in its
6 absence.

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FIG.1

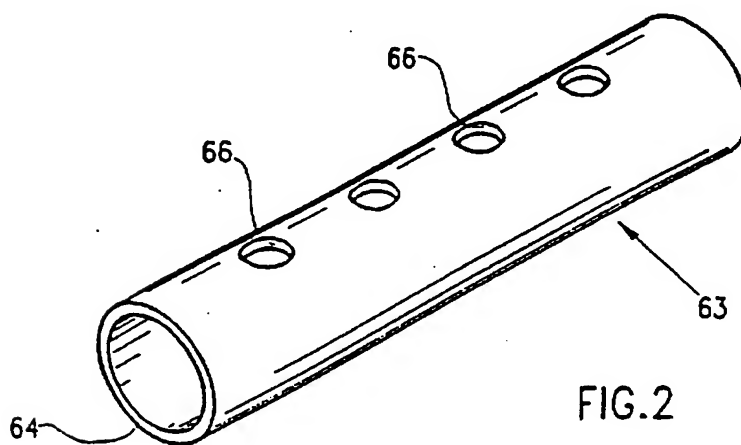
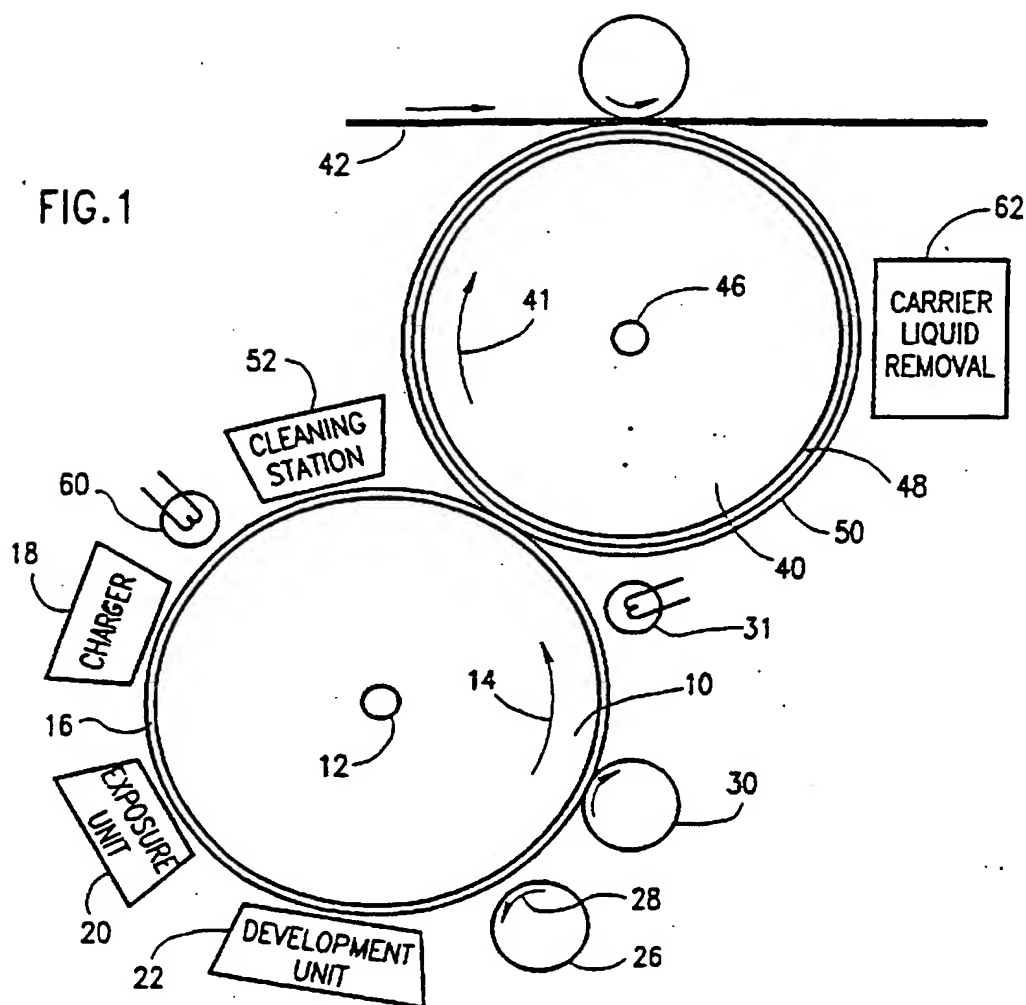


FIG.2

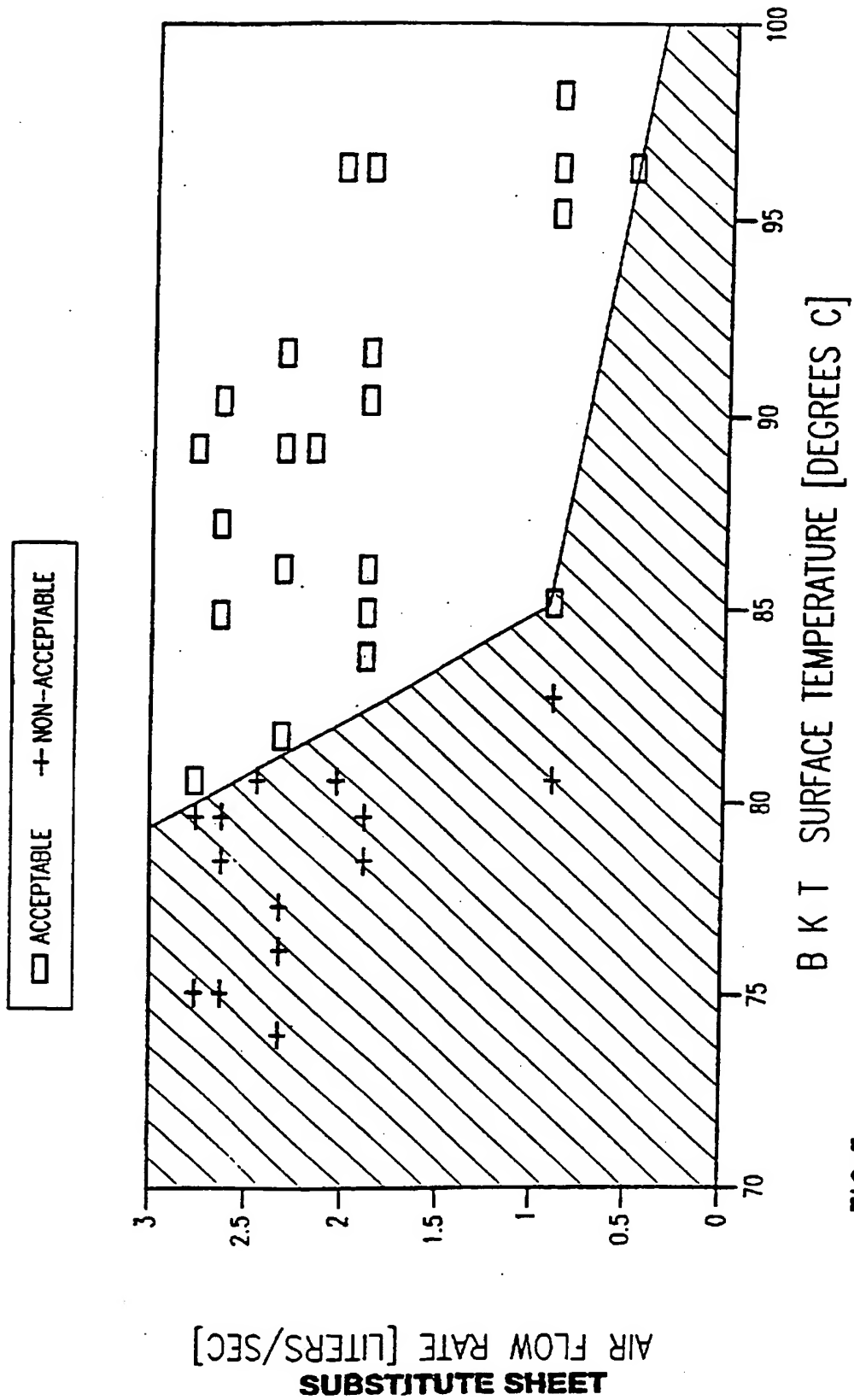


FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No

PCT/NL 93/00193

A. CLASSIFICATION OF SUBJECT MATTER
IPC 5 G03G15/01 G03G15/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 5 G03G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 016, no. 159 (P-1339)17 April 1992 & JP,A,04 009 087 (SEIKO EPSON CORP) 13 January 1992 see abstract ---	1
A	PATENT ABSTRACTS OF JAPAN vol. 016, no. 035 (P-1304)28 January 1992 & JP,A,03 243 973 (SEIKO EPSON CORP) 30 October 1991 see abstract ---	1
A	EP,A,0 247 838 (XEROX CORP) 2 December 1987 cited in the application see the whole document --- -/--	1

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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- * "E" earlier document but published on or after the international filing date
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* "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

* "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/NL 93/00193

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP,A,0 364 855 (OCÉ NEDERLAND B.V.) 25 April 1990 see the whole document ----	1
A	PATENT ABSTRACTS OF JAPAN vol. 008, no. 259 (P-317) 28 November 1984 & JP,A,59 129 888 (KONISHIROKU SHASHIN KOGYO KK) 26 July 1984 see abstract -----	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/NL 93/00193

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		DE-A- 3775988	27-02-92
		JP-A- 62289876	16-12-87
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		JP-A- 2137857	28-05-90
		US-A- 5001030	19-03-91
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